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AUTHOR Laveault, Dany; Leblanc, Raymond; Leroux, Janice
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ABSTRACT

This paper examines how self-evaluation strategies contribute to helping students take control over their own learning processes. In addition to examining the role of self-evaluation when a student takes on and exercises control over an activity in the classroom, this paper takes into account homework assignments and the role of parents. Subjects (N=45) were in 6th-8th grade. They were distributed almost equally according to gender, grade level, and ability level. Twenty-nine parents completed a questionnaire about their child's homework assignment. The activity in class and the homework assignment consisted of a real-life mathematics task. The students compared products in two stores to choose the best bargains for a pre-determined checklist of school supplies. The mathematics involved arithmetic operations, percentages, and problem solving. Findings show that results obtained by grade 6 students were significantly higher than those of grade 7 and grade 8 students. This finding might indicate that the task was easier for grade 6 students. No differences were found between boys and girls regarding success at the task completed in class or at home. Gifted students performed better and had a higher level of agreement with their parent concerning the homework. Results highlight the complexity of the interaction between metacognition and motivational self-regulated variables. The importance of further research in this area is discussed. (Contains one figure, seven tables and 17 references.) (Author/MKA)

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SELF-REGULATED LEARNING OF YOUNG ADOLESCENTS IN A MATHEMATICS ACTIVITY[1]

Dany Laveault, Raymond Leblanc and Janice Leroux
University of Ottawa, Faculty of Education

Keywords: social cognition, academic self-regulation, early adolescence, learning disability, mathematics, talented and gifted.

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Academic evaluation at its best teaches the student to plan, regulate, and monitor his or her learning. With respect to the evaluation process, the model teacher prepares students for optimal success so that they improve their capacities, develop their skills and construct knowledge, all of which represent the real goals of education (Resnick & Resnick, 1991).

In a learning context which encourages the student to exert control over his/her own learning (self-regulated learning) two academic determinants seem all-important: achievement motivation which is linked to self-efficacy perception and metacognitive thinking which emphasizes awareness and control of cognitive strategies required to succeed.

Self-regulated learning, or the process that mobilises and reinforces cognitions, behaviours, and affects toward goal attainment (Zimmerman, 1989, 1990), is an integral component of the formative function of learning and even more so as Scallon (1997) expressed it, of the formative evaluation of autonomy. A culture of learning that encourages the student to exercise his or her self-regulated strategies when participating in an activity or when studying or doing homework is essentially formative, in that it contributes to better overall functioning and rewarding anxiety-lessened academic performance.

Academic self-regulation seems to be independently influenced by self-efficacy perception on one hand (Bandura, 1997), and by self-evaluation during and after a performance on the other hand. Our research program aims at studying the contribution of these two regulatory factors with three categories of young adolescent learners: regular students, learning disabled students, and gifted or talented students.

Self-efficacy perception

Human action is composed of three classes of determinants organised in triadic reciprocal causation: behaviour, internal personal factors in the form of cognitive, affective and biological events, and external environment (Bandura, 1997). Self-efficacy perception is a cognitive determinant that regulates the functional relations between personal factors and adaptation and change. Self-efficacy causality regulates motivation and action (Bandura, 1997). It is then the central mechanism of intentional human action. The learner believes it is possible to accomplish anything he or she attempts when relying on his or her own capacities.

In a social cognitive perspective, manifest behaviour, effort, and persistence are regulated by self-efficacy perception. Efficacy perceptions vary on three dimensions: they differ in level and generality and vary in strength. Achievement motivation depends on the social culture of the academic environment of the student. The level of satisfaction and the level of enjoyment of the student are higher when the classroom environment is perceived as encouraging initiative, spontaneity, personal responsibility, and a commitment to understanding and learning (Fry & Coe, 1980; Ryan & Grolnick, 1986; Nicholls & al., 1985). When a classroom environment is predominantly goal-oriented, the result is usually a more varied and challenging choice of tasks, more positive attitudes toward peers, more efficient learning strategies, and a stronger belief that success comes from effort (Ames & Archer, 1988).

Metacognitive perspective

The metacognitive perspective focuses on analysing the cognitive activities involved in the conscious and deliberate control that a person develops over her own cognitive processes (Pinard, 1987). Conscious and deliberate control is exerted over goal-oriented processes (Zimmerman, 1989, 1990). These self-regulated

processes are responsible for global planning, as well as the use of strategies, controls, and checks necessary to organise knowledge during cognitive processing (Lefebvre-Pinard & Pinard, 1985). Therefore, these processes promote performance efficacy and behaviour monitoring. The social cognitive theory of self-regulation suggests a bi-directional relationship between the beliefs and behaviours of the learner. On the one hand, self-efficacy perception influences behaviour associated with success; for example, it influences task choice, effort, and persistence. Students who have a high level of self-efficacy do not hesitate to engage in a task, to exert effort, and to persist even in the presence of obstacles (Schunk, 1996; Zimmerman, 1995). Self-efficacy perception can therefore be considered a proximal predictor of the quality of self-regulation in performance. (Bandura, 1997). On the other hand, it is by working valiantly and by taking mental notes regarding their progress that students feel more competent and, at the same time, develop a stronger sense of self-efficacy (Schunk, 1989).

Several strategies can be applied in self-regulated learning. A list of fourteen strategies have been proposed by Purdie and Hattie (1996): self-evaluation, organisation, transformation, goal setting, planning, search for information, self-reinforcement, search for social support, revision, memorisation, environmental setting, repetitive practice, note-taking, and self-management. In classroom teaching, these strategies do not all have the same importance in terms of the level of control given to the students and in terms of the reciprocal interplay between cognitive involvement and achievement motivation.

In our research program, we want to examine more specifically how self-evaluation strategies contribute to helping students take control over their own learning processes. Self-evaluation is defined here as the process by which subjects judge the quality of their progress, of their performance, and of knowledge acquired with respect to intended goals based on specific criteria (Legendre, 1993). In this respect, self-evaluation might be considered to play an essential role in the student's progress towards more autonomy and responsibility, most evident during the transition years from elementary to secondary school.

A number of developmental studies seem to indicate that both a student's motivation and self-efficacy perception show numerous changes during this period (Wigfield, Eccles, & Rodriguez, 1998). Thus, in addition to examining the role of self-evaluation when a student takes on and exercises control over an activity in the classroom, we also took into account homework assignments and the role of parents. In fact, as is the case with teachers, the expectations and the role of parents change considerably during this transition period and they have a direct effect on the student's achievement motivation and even more on his cognitive involvement.

Methodology

Subjects

Forty-five grade 6 to 8 students participated in this study. These students are distributed almost equally according to gender, grade level, and ability level. They come from four different class groups and homeroom teachers. Twenty-nine parents (father, mother, or legal guardian) also completed a questionnaire about the homework assignment of their child.

Instruments

The instruments included a student questionnaire, a parent questionnaire, and an interview grid. A description of each of these instruments follows:

- Student questionnaire
- A questionnaire completed by the student before the interview. This questionnaire was administered to the student after the teacher introduced the activity in class. It allowed the student to focus on specific points that would later be discussed during the interview.

- A semi-structured interview questionnaire which included items that would be discussed individually with the student before he or she started and after he or she completed the activity. The questions concerned the following areas:
  - motivation: importance, goals, effort
  - task familiarity
  - evaluation: student's expectations regarding his or her level of performance and the level of performance of his or her peers, level of confidence about anticipated success or difficulty
- A questionnaire about the homework assignment to be completed at home: expectations as to effort, level of confidence regarding the eventual score, expectations as to the time required to complete the homework assignment.

- Parent questionnaire
  - A questionnaire about the homework assignment of the student. The parent answered the same questions as his or her child.

The activity in class and the homework assignment consisted of a real-life mathematics task. The students compared prices in two stores to choose the best bargains for a pre-determined checklist of school supplies to be purchased for the upcoming school year. The mathematics involved arithmetic operations, percentages, and problem solving.

Procedure

Figure 1 illustrates the observational design of the study. Six persons conducted the interviews with the 45 students. This number of interviewers was necessary in order to reduce the time period between the time when the student was first introduced to the activity and the time when he/she was invited to discuss it. Similarly, interviews were conducted immediately after the student completed the activity.

All activities were completed in one day. Each of the four class groups started the activity thirty minutes apart, in order to be able to conduct the interviews as soon as possible after the introduction of the activity or after its completion. Each five to ten minute interview was audio-recorded and transcribed.

Insert Figure 1 here

At the end of the day, the students took home an assignment which was an extension of the activity they had done in class. Two questionnaires accompanied this homework: one for the parent and one for the student. Each questionnaire was completed individually, placed in a sealed envelope, and then returned to the school.

Description of variables

Two types of variables were considered in the data analysis:

- measured variables: these are the variables that directly correspond to answers given by a student for questions on one of the instruments.
- constructed variables: these are variables that were created from a group of questionnaire responses.

Measured variables can also be classified as attribute variables, independent variables, and dependent variables:

- Attribute variables. They encompass all of the subject characteristic measures that were used to describe the sample in the methodology section:
    - gender
    - ability level
    - grade level

- Independent variables. They consist of the answers given by the student to the different questions they were asked concerning their metacognitive strategies and their motivation. These are:
  - For the student
    - measured variables before or after completion of the task in class
    - measured variables before of after completion of the homework assignment.
  - For the parent
    - measured variables before and after completion of the homework assignment.
- Dependent measures. They correspond to the results given by the teacher who marked the students' assignments:
  - Results for the task completed in class
  - Results for the homework assignment completed at home

The constructed variables are all independent variables. These are:

- The "agreement" variable indicates the number of times the estimates of the parent and of the student were identical for the assignment completed at home.
- The "estimate #1" variable indicates the differences between the time estimated (before the task) by the parent and by the student to complete the homework.
- The "estimate #2" variable indicates the differences between the time calculated (after the task) by the parent and by the student to complete the homework.
- The "confidence" variable indicates the differences between the confidence level of the parent and the confidence level of the student with regards to the homework.
- The "goal" variable indicates the differences between the goal set by the student (before the task) and the result obtained.
- The "time" variable indicates the difference between the estimated time by the student after completion of the task in class and the estimated time before the task.

The data analysis was done in two parts. First, comparison tests were performed to determine whether a significant difference existed for the measured and constructed variables according to gender, grade level, and ability level. Then, we examined correlations between variables according to the following perspectives:

- correlations between responses to the questions before the task completed in class.
- correlations between responses to the questions after the task completed in class.
- correlations between responses given before and after the task.
- correlations between the different constructed variables.

Data are omitted when the student did not provide an answer. For example, questions for which the response "no opinion" was given were considered as missing data, as well as questionnaires and homework assignments that were not returned by students.

Results

Differences between school levels

The principal differences between grade level are illustrated in table 1. The analyses of variance that were significant in grades 6 to 8 are highlighted.

Insert Tables 1a, 1b and 1c here

Table 1 indicates that the results obtained by grade 6 students are significantly higher than those of grade 7 and grade 8 students. This finding might indicate that the task was easier for grade 6 students.

Consequently, the difference between the results on the task and the intended goal is also significant. The intended goal of grade 8 students being similar to that of grade 6 students, the difference between the result obtained and the goal is larger.

This difference between the difficulty of the task for grade 6 students on one hand, and for grade 7 and 8 students on the other hand, seems to have also been perceived by both the students and the parents. In fact, the results indicate that parents of grade 7 and 8 students estimated that it would take twice as much time for their children to complete their homework than the time estimated by the parents of grade 6 students. The grade 7 students estimated that they would need twice as much time as they actually did to complete the task, and for those in grade 8, estimates were three times higher. Finally, the median level of confidence with respect to being successful at the task for both before and after task completion was much lower for grade 8 students.

Differences between boys and girls

Comparison tests were performed on all variables in order to determine the presence of significant differences between boys and girls. These tests were performed irrespective of the specific ability level because girls and boys are almost equally represented in each category of ability level. No differences were found between boys and girls regarding success at the task completed in class or at home. For all comparisons, few differences were significant at the critical threshold of 0.05. The significant differences are presented in tables 2a and 2b.

Insert Tables 2a and 2b here

These results show that girls attribute more importance to the task than boys. For example, 13 out of 20 boys found the task "important" while 13 out of 23 girls found the task "very important". While more boys

estimated beforehand that the task would be easy or very easy, more girls estimated that the task would be a little difficult. When interviewed about task difficulty after its completion, 10 out of 23 girls and only 3 out of 19 boys found it more difficult than expected. The same perception was observed for the estimated time to complete the homework assignment. In general, girls estimated that they would need more time than boys (table 2b).

In summary, despite the fact that girls succeeded in the same proportion than boys on both task, the former generally attributed more importance to the task and estimated it to be more difficult after than before its completion. They also estimated that it had taken them more time to do their homework. Finally, a larger number of girls (19 out of 23) than boys (9 out of 19) changed their opinion about the difficulty of the task performed in class.

Differences between students of different ability levels

Comparisons between results obtained by students from the three categories of ability level were performed on all the research variables by using a 0.05 level of significance. These comparisons were performed for all grade levels irrespective of the gender of the students. Two types of comparisons were performed:

- Kruskal-Wallis tests for k independent samples (table 3a)
- ANOVA for k independent samples (table3b)

Insert Tables 3a and 3b here

Table 3a and b results show that gifted and talented students (GT) performed better on both the in-class task and the homework assignment. These findings also suggest the gifted students had a higher level of agreement with their parent concerning the homework. It is important to note that a larger proportion of parents of students in both learning disabled (LD) and regular (RE) categories returned the questionnaires –

over 90%. This proportion was only 28 % for the parents of gifted and talented students. These results might indicate that gifted and talented students completed their homework without their parents' help.

Table 3b presents the significant results of the analyses of variance for the time estimated to complete the homework assignment by both the parent and the student. Both before and after the task, parents of gifted students estimated that it would take their children less time to complete the homework. These parents also generally estimated that it would take their children less time than the children had predicted for themselves. The opposite was found for parents of learning disabled students: they provided time estimates generally greater to those of their children. Finally, the results also indicate that gifted and talented students had a better score on the task than learning disabled students, but that this score was not different from the mean score of regular students.

Strong correlations

Between the responses on the interview before doing the task in class

When we analysed the measures taken before the student completed the task in class, we found many correlations. The number of subjects does not allow us to perform a factor analysis on the results, therefore, only the strongest correlations are presented.

The variable that was found to be most often correlated with other variables was the one measuring the level of confidence of the student regarding his or her perception of succeeding at the task. The level of confidence was strongly correlated in the three following situations:

- the clearer the student's understanding of the task, the higher his or her level of confidence (rho=0.585, $p<0.01$).

- the clearer the student's plan of how to perform the task, the higher his or her level of confidence with respect to succeeding (rho=-0.340, $p<0.05$).
- the higher the student's level of confidence in terms of succeeding on the task, the higher the goal he or she set (rho=0.381, $p<0.05$)

Finally, two other correlations were observed between the following variables:

- the more the student liked the kind of mathematics activity he or she was given, the less time he or she estimated would be required to complete it (rho=-0.354, $p<0.05$).
- the clearer the task for the student, the more likely he or she was to have a plan on how to proceed (rho=-0.399, $p<0.01$).

Between the responses on the interview after the task had been completed in class

When examining the measures taken after the student completed the task in class, we observed that the student's perception with respect to the level of difficulty of the task was correlated with his or her perception of the level of difficulty the task would present for other students:

- the smaller the number of his or her peers a student perceived as being able to succeed, the higher the number he or she felt would be needing help (rho=-0.590, $p<0.01$).

Between the responses before and after the task completed in class

A large number of significant correlations were found between, on the one hand, a student's level of confidence with respect to his or her ability to successfully complete a similar activity in the future, and, on the other hand, his or her responses to a list of questions asked before the task was begun. Generally, students were more confident that they would succeed on a similar task when:

- they had stated they liked mathematics (rho=0.327, $p<0.05$).
- they considered the task to be important (rho=0.356, $0<0.05$).

- the task was clear to them (rho=0.330, $p<0.05$).
- they already felt confident before starting (rho=0.529, $p<0.01$)

When we asked the students to estimate how many of their peers would likely succeed at this task, their responses were often correlated with other responses given before starting the task. For example:

- the higher his or her estimate, before starting the task, with respect to the time it would require, the smaller his or her estimate, after completing the task, of the number of students that were likely to succeed (rho=0.350, $p<0.05$).
- the higher his or her estimate, beforehand, of the number of students that would not do well, the higher his or her estimate afterward of the number of peers that had required help (rho=0.350, $p<0.05$).

Finally, the estimates given by the student were generally accurate. For example, there is a strong correlation (rho=0.772, $p<0.05$) between the time requirement estimated before and after completion of the task.

Between the different constructed variables

Spearman rank correlations were performed on all constructed variables. Only significant correlations to 0.05 level will be presented.

First of all, we observed a strong correlation between the score for the degree of agreement between parents' and children' responses to three identical items from the questionnaire and several other variables listed below:

- the higher the level of parent-child agreement, the higher the score on the task performed in class – which was different from the homework assignment (rho=0.614, $0<0.01$).

- gifted and talented students showed the highest the level of parent-child agreement (rho=0.508, $p<0.05$).
- the level of parent-child agreement decreased with grade level: grade 6 students seemed to show more agreement with their parents than did grade 7 and grade 8 students (rho=-0.444, $0<0.05$).

The difference between the level of confidence expressed by parents and their child also correlates with several variables:

- the children whose parents were more confident about their ability to succeed were the ones who performed better on the homework assignment (rho=0.484, $p<0.05$);
- the children who were less confident than their parents were in grades 7 and 8 (rho=0.404, $p<0.05$).

Finally, gifted and talented students scored higher on the homework assignment (rho=0.488, $p<0.01$).

Between the measured variables for the homework assignment

Apart from the above observations with respect to parent-child level of agreement and other variables, no parent or child response to the questionnaires that accompanied the homework assignment gives any insight as to the degree of success achieved.

Discussion and conclusion

The results highlight the complexity of the interaction between metacognitive and motivational self-regulated variables. This level of interaction is so important that it is sometimes difficult to determine afterward if the responses to some questions were more cognitively or motivationally regulated. For example, we have shown that the clearer the task appears to the student, the higher his or her level of confidence with respect to succeeding. However, we might wonder whether the task is clear because the

student is confident in succeeding or whether he or she is confident to succeed because the task seems clear. Another example of the complexity of variable interaction is the issue of the student's perception of time required to complete the task as determined by whether or not he or she likes the task. Students' perception of task difficulty also seems to influence their perception of the help their peers would need. When students estimate before attempting the task that they are capable of successfully completing the task, their estimate after completing the task is that their peers needed help.

The results also allowed us to observe some individual differences between grade level, gender, and ability level. Girls, for example, attributed more importance to the task, predicted it would take them more time to complete the task, and more readily changed their initial perception. Grade 6 students were generally more confident before and after having performed the task in class. The difference between goal setting and success is also lower for them. These results seem to confirm recent observations by Wigfield, Eccles, and Rodriguez (1998) about the development of self-efficacy and its impact on student performance during the transition years (grades 6, 7 and 8). As to ability levels, it was found that gifted and talented students showed a higher level of agreement between their own perceptions and those of their parents. The higher the level of agreement, the higher their results in the classroom. The role that parents play in achievement motivation, that is effort exerted and persistence on task, was also illustrated by our results: students whose parents had expectations that were more optimistic than their own were also the better performers of our study.

The findings point to the importance of further research on metacognitive strategies while taking into account factors such as academic subject, ability level, grade level and gender. However, our observations raise several issues with respect to between-subject comparisons. Two of these issues are:

- it is difficult to find a common, interesting, and challenging activity for students of different grade and ability levels.

- it is also important to take into account teacher effect both in terms of how he or she introduces the activity and what learning climate prevails in the classroom.

These difficulties are not insurmountable. They do however require the use of alternative strategies:

- the teacher's influence might be reduced by proposing activities that encourage more student control.
- it seems more important to compare diverging perceptions for the same student or for the same category of students (between before and after the task, between goal setting and obtained results, between his or her own expectations and those of the teacher) than it is to compare individual perceptions of many students.

Finally, the correlations obtained between cognitive and motivational variables, and their corresponding impact on performance, suggest that it is better to focus on the larger context of academic self-regulation without trying to specify its nature (metacognitive or motivational). These differences can often be attributed more to the perception of the observer rather than to the person observed.

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Figure 1: Observational design

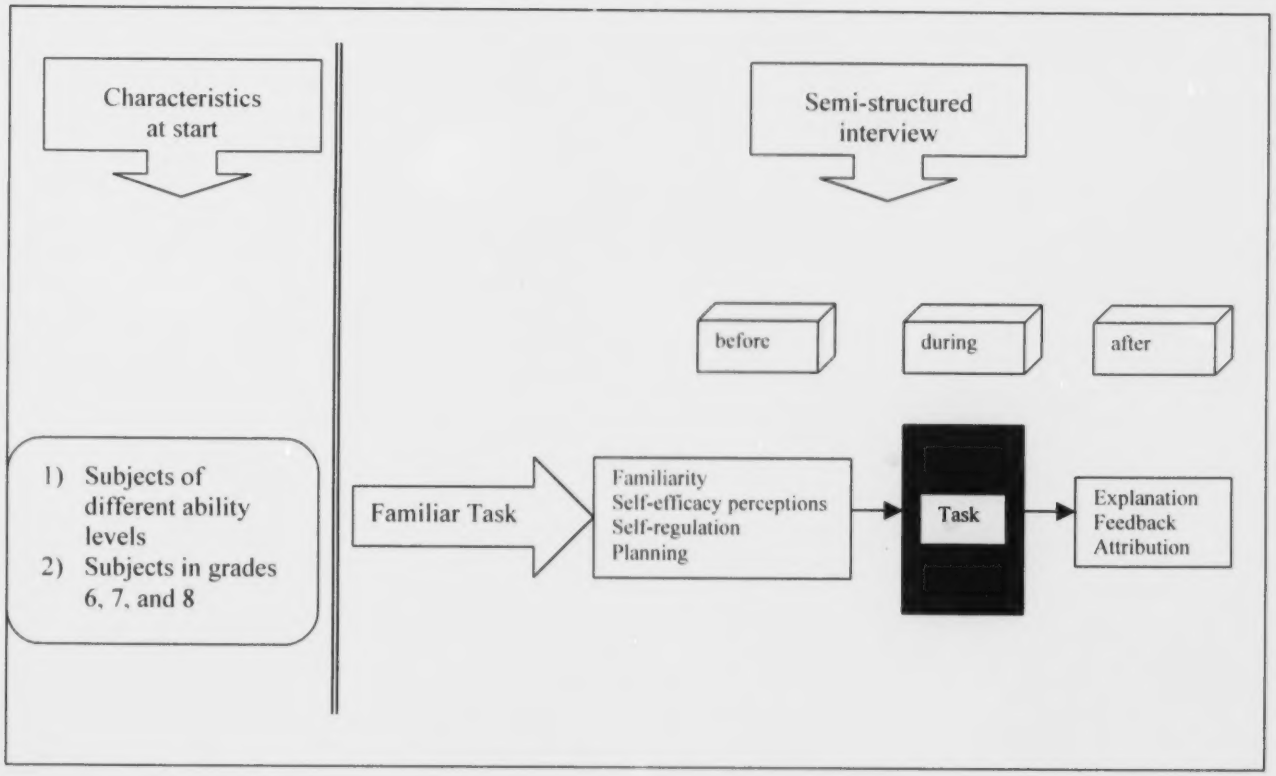

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Table 1a. Comparisons between students from grade 6 to grade 8. ANOVA for independent samples.

Variable	Means			f	p
	6 n=14	7 n=17	8 n=14		
In-class task (T)**	2.6	2.1	1.9	4.6	0.016
Difference between task and set goal (GOAL)	-0.5	-0.9	-1.1	3.5	0.041

** based on the holistic notation system from the Ontario Ministry of Education

Table 1b. Comparisons between students from grade 6 to grade 8. ANOVA for independent samples.

Variable	Means			f	p
	6 n=14	7 n=6	8 n=9		
Parent's estimate of the time needed to do the homework before the student starts it (PQH5)	12	21	28	4.2	0.027
Anticipated estimate of the time needed to do the task in class (SQA7)	19	41	57	15.5	0.000
Anticipated estimate of time needed to complete the task in class (B9)	19	35	54	30.4	0.000
Time estimated after to completing the task in class (A7)	21	40	59	15.8	0.000

Table 1c. Comparisons between students from grade 6 to grade 8. Kruskal-Wallis analysis of variance for independent samples.

Variable	Means			f	p
	6 n=14	7 n=14	8 n=12		
Level of confidence before (B14)	3	4	2	8.802	0.012
Level of confidence after	4	4	3	8.039	0.018

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Table 2a. Comparisons between boys and girls.
Mann-Whitney U test for two independent samples.

Variable	Z value	p
Estimation of the level of difficulty before the task in class (B5)	-2.24	0.025
Estimation of the level of difficulty after the task in class (A4)	-2.51	0.012
Importance of the task (B2)	-2.37	0.018

Table 2b. Comparisons between boys and girls.
Student t test for two independent samples.

Variable	Means		t	p
	Boys n=18	Girls n=5		
Student / before*	13	19	2.14	0.039

*: estimate of the time needed (in minutes) to complete the homework

Table 3a. Comparisons Between the three ability groups.
Kruskal-Wallis test for k independent samples.

Variable	df	Chi-square value	p
Level of agreement (AGREEMENT)	2	6.179	0.046
Homework (T)	2	8.337	0.015

Table 3b. Comparisons between the three ability groups.
ANOVA for independent samples.

Variable	Means			f	p
	LD n=10	RE n=10	GT n=5		
Parent/ before* (PQH5)	29	10	10	6.9	0.005
Parent/ after* (PQH6)	24	9	8	8.7	0.002
Student/ before* (SQH5)	25	11	9	7.3	0.004
Student/ after* (SQH6)	20	8	7	9.1	0.001

* : Estimate of time needed (in minutes) to complete the homework

Variable	Means			f	p
	LD n=10	RE n=10	GT n=5		
In class task** (HMW)	1.8	2.3	2.3	3.2	0.05

** Graded out of 4, the maximum of the holistic notation system of the Ontario Ministry of Education
DA: learning disabled group of student
RE: regular group of student
DT: gifted and talented group of student